Thesis.

Wind Power and Irrigation.

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Contents.

There was a time when wind and water were the only natural motive forces at man's command. They are both forces of nature made subservient by man for industrial purposes. We may witness the destructive effects of the wind in the storms, tornadoes, and in the path of the much dreaded cyclone. That it may be a power for good may be seen from the numerous white sails that dot our seas, carrying our commercial interests, that, in some places, competes successfully with steam. Beautiful Holland is partially reclaimed from the sea by the aid of the motive force of the wind properly applied. There the well known "Dutch" mills have been used for ages, some of them it is claimed have with stood storm and wind for over five hundred years. They were used for both pumping and grinding, and their peculiar construction makes their appearance, during motion, interesting and suggestive.

Behold! a giant am I!
Aloft here in my tower.
With my granite jaws I devour
The maize, the wheat, and the rye,
And grind them into flour.

On Sunday I take my rest,
Church going bells begin
Their low melodious din;
I cross my arms on my breast,
And all is peace within. (Longfellow.)

When the expansive force of water vapor was discovered further improvement upon the windmill ceased, but now a reaction has set in and the windmill is winning its way back into popularity again, becoming, along certain lines a formidable competitor of steam. It was left for the "Yankee" with his skill and energy to develop this form of motor, and today, there are, placed within easy reach of the farmer, wind engines that are marvels of industry, if properly handled, and cared for. They are much more efficient than the old "Dutch" mills and are replacing them in Holland and Germany.

Although there has been considerable development along this line, the demand has not been anything more than ordinary. Professional engineers of ability have been asking themselves, why are wind mills not more generally used? Their cheapness and economy are being recognized, now, more and more all the time, and since the irrigation question has been causing so much agitation, a new field of usefulness has been opened up and men are hard at work developing better constructions. More wind mills are being used now than ever before. It has been estimated by some at several hundred thousand but the number has increased wonderfully within the past year. If we realize all that is expected of it, the wind mill has only begun its development.

The irrigation problem is one that is engaging the minds of some of our best and brightest men. Upon its solution depends the development of an immense territory, aggregating several hundred thousand square miles, of which western Kansas is the centre north and south. A number of failures, caused by lack of sufficient rain fall, have demonstrated conclusively, that, through this semi-arid tract, irrigation must be practiced, if it is to become habitable and prosperous. A good portion of this land will yield bountifully, if water can be obtained and applied in sufficient quantity. One phase of this subject we shall attempt to treat.

Water for irrigation purposes may be obtained from several sources. 1st from running streams. 2nd by storage of storm water before it reaches the streams and runs away, 3rd from the under flow or subterranean water. The latter two are attracting attention in Kansas. The storm water is utilized by building dams across a draw or basin; here accumulates the water from the drainage basin, and when needed is let out in canals. The other source, and one in which we are most interested, although not quite so general, is of vast importance.

Along the streams of eastern and central Kansas, water, in large quantities, can be found by digging down to the level of the streams. Here, in the sand, there seems to be a sheet of water, which dry weather does not materially affect. In the north central part, and covering about 9,000 square miles, there is found, beneath the surface, a kind of sand rock formation. Through this the water will find its way, and, owing to the rock formation, be absorbed, like a sponge, until the point of complete saturation is reached. The flow through the rock is not very rapid, and some wells that did not at once yield a large volume were abandoned. Whenever this rock formation is found, an ample chamber must be provided in order that the water may have free access, or the supply will be exhausted, after a few strokes of the pump. It has been estimated by scientists that, one square mile of sand stone, one hundred feet thick, once thoroughly saturated, will hold water enough to flow continuously, one cubic foot per minute for thirteen years. If Geology is of any use to us, here is where it ought to show its utility. Geologists are able to tell by the formation and dip of the strata, where such localities are likely to be found and the probable water supply. Water upon the surface always follows the slope of the country, but it does not necessarily follow that the subterranean water flow in the same direction, as that upon the surface. It obeys the same law, that of gravity, and follows the dip of the strata, which may or may not be the same as that of the surface. For this reason wells upon highland may reach water sooner than those upon a lower elevation, to the uninformed this often seems mysterious. West of this sand stone region is a large scope of country, from which nearly all the water runs away in streams, owing to the impervious nature of the soil. West of this, and including nearly all of the western part of the state, is found the, much talked of, sheet water or under flow. The extent of this underflow is not known, but here is a tract of land aggregating

20,000 square miles of which it is estimated that twenty five per cent may be irrigated. The soil is loose and alternates with layers of sand and gravel, giving it great absorbative powers. The water is held by the soil and percolates slowly through it until the impervious chalk beds beneath are reached. Here the water has been accumulating for years. and there must be under-lying this country an immense sheet of water.

In Sherman County this underground supply is reached at a depth varying from 50 to 150 feet depending upon the configuration of the country. At one place three large steam pumps, situated within a few feet of each other, have been working for several years without any apparent diminution in the local supply. In Finney County the water comes in some places within a few feet of the surface.

Our rivers do not furnish a constant supply of water, but go dry or diminish in flow during dry seasons. Several of the irrigating ditches along the Arkansas River are useless for this season. Already this season there comes the complaint of a scarcity of water because the irrigators in Colorado are using so much. Artesian wells are found in some places, but the geological formation of the country is such that they can not be depended upon to furnish a very great supply for irrigating purposes. The storage of storm waters will give a varying supply. In wet years there will be an immense quantity; in very dry years an insufficient amount. Since these sources can not be depended upon, the future success of irrigation, in places where under ground water exists in quantities, depends, largely, upon how we can get it to the surface. In some places where it is not deep from the surface it has been led out by gravity, but over the greater part of the territory this method cannot be employed, leaving some mode of lifting it out as the only means by which it may be made available.

If any large part of our state is artificially watered and we cannot depend entirely upon these other sources, then we must use wells. The greater proportion of governmental aid should be along this line, determining, the extent and amount of the underflow, and the cost of bringing it to the surface. Our State Legislature has recently passed a bill authorizing the establishment of twenty experimental plants, some of which have already been located. The success, largely, of this mode of irrigation will depend, upon individual enterprise, but with a little help better results may be attained.

We cannot get out subterranean water in sufficient quantity in any one locality to irrigate all of the irrigable land. Out of 160 acres probably only from 10 to 30 can be watered. This then means a large number of small irrigating plants, owned and controlled by the farmers themselves. Where irrigating is done with canals and reservoirs, an immense amount of capital is required to start the enterprise. The consumers themselves are put to much worry and expense; water rates are high, sometimes exhorbitant, and in our semi-arid region the water may not be all needed, if the season be damp. It sometimes happens that just when you want to use the water, some one else wants to use it also, and, if the supply be inadequate, vexatious delays are the consequence. Individual plants obviate the most of these difficulties. Water cannot be obtained in any ~~any~~ other way by individual farmers, except through irrigation companies. This method enables the farmers to be independent of each other so far as irrigation goes. They can apply just as much as they want at just the time when they want it.

It is unnecessary to emphasize the importance of cheap power for irrigating purposes. Fuel is dear on the western plains

, and while steam or some form of gas engine might do for irrigation companies, they are too expensive for the single handed farmer. The small farmers are the backbone and sinew of our nation, and any agency that will enable them, with a small capital, to compete successfully with the individual millionaire capitalist may be regarded, in one sense, a boon to humanity. Here, I think, lies the great significance of the wind mill question.

The wind is undoubtedly the cheapest form of power known at the present time. The power that annually sweeps over our prairies is certainly great, and the plan of putting a part of this wasted energy to such a good use is one that appeals strongly to the farmer. He is interested in the solution of the problem of successful wind mill irrigation. Wherever there is an exhibition of irrigating machinery, the interest centres about the wind mill display. Authorities on irrigation questions receive letters, by the thousand, from persons seeking information upon the feasibility of pumping water for irrigation, and especially about wind power. Pumping water by this means is yet in its infancy. It is attracting the attention of manufacturers who have men upon the field studying the question from a practical standpoint.

There are many different makes of wind mills upon the market and I think without exception they are of the vertical type. They all claim to be good and they probably are, but undoubtedly some do possess superiority over others. All have their admirers, some persons say one make is the best, others another. A few of the principle ones are, The Halladay, Aermoter, Gem, Ideal, Challange, U.S. Wind Engine, Perkins, Eclipse. Ect. Wind mill makers are seeking constantly to improve both their mills and pumps, but care should be taken in selecting some of the new fangled, arrangements; many of them are but experimental machines that have not been thoroughly tested yet. Some of them seem to be made to sell, but a lack of utility will soon drive them from the market.

In the past, the majority of the mills and towers have been constructed of wood, but now the all steel tower and all steel wheel find favor in some localities and are steadily coming into use. If properly constructed, they are fully as strong as the wooden structures, and much more durable and powerful. Some of the mills are geared so that the wheel makes two or more revolutions to one stroke of the pump. It is obvious that such a mill will run with a lighter wind than the direct stroke, and the loss of power by the vibration of the pump rod, especially in deep wells, is greatly lessened. This is an important point often overlooked in the fast stroke mill, but it is yet to be deter-mined whether or not the geared mill will pump as much water during an entire season, even with a larger pump. Sometimes it might be an advantage to have a geared mill; during a period of light winds it might run when others would not and thus give a supply of water when most needed. The Aermotor is a mill of this kind, and claims for an 8 foot wheel an efficiency equal to that of a 10 foot wheel of any other make.

If we accept the statements of manufacturers in calculating the amount of work a wind mill will perform, we are likely to fall into error, because they are not to be relied upon. The calculations are made upon too large a basis. Since the power of a mill increases with the cube of the velocity of the wind, by raising it just a little above the normal, the result might be changed very materially. Some of the mills have been tested under the most advantageous circumstances, and they failed to give the power claimed for them.

so unless the buyer be on his guard he will be misled by these false statements.

From good authority we learn that the average daily wind velocity for this part of Kansas is 12 miles per hour. farther west it is greater. Experience has demonstrated that a mill will not run in less than a six mile wind, making the light breezes useless in this respect, but leaving them out of account an average of 15 miles per hour for 18 hours per day may be relied upon as an average for a whole year. An average for the growing season of six months is much less, during the latter end of the period the average monthly velocity is quite low. with a 16 mile wind a 10 foot wheel will give about 1/8 horse power, usually rated by the makers from 1 to 1½ horse power. With an increased diameter of the wheel the power increases rapidly; a 14 foot wheel giving .28 HP, an 18-foot .61 HP, 20 foot .78 HP, and a 25 foot, 1.34 HP.

It is obvious to a person with a little knowledge of Mechanics, that it will take twice as much power to raise twice the amount of water to the same height, It is equally true, other things being equal, that it will require twice the power to raise the same volume of water to twice the height. If we have a mill that will raise 50 gallons of water per minute and double the power, it will lift 100 gallons. In the other case if a mill will pump 50 gallons per minute from a well 25 feet deep it will pump only 25 gallons from a well 50 feet deep, or in other words we would have to double the power to raise 50 gallons per minute from a 50 foot well. This is a fact overlooked by some and not thought of by others, but is never-theless an important factor in determining the cost of pumping. While theoretical calculations are of inestimable value to the engineer in solving problems of this character, unless he be a thorough student of Mechanics, and is able to take into consideration all of the factors and determine their relative effect, his calculations and deductions are likely to be worse than useless. For this reason I will not enter farther into the mathematics of wind mill construction, but will base my remarks upon what I have been able to draw from the practical experience of other men.

The wind mills, used for irrigating purposes, range from 8 to 12 feet in diameter, a few 16 foot wheels are used, but it is seldom we find any larger. An ordinary 10 foot wind mill will raise from a 10 or 15 foot well about 29,000 gallons per day, or allowing some for seepage, enough to cover one acre one inch deep. As the well increases in depth the diameter of the wheel must be increased to raise the same amount of water. If the well be from 25 to 40 feet deep a 12 foot mill will deliver, with an 8 inch pump, from 65 to 75 gallons per minute, when the wind is blowing at an ordinary rate.

Experience has shown that cultivated land requires at least 24 inches of water annually to grow a crop; so what nature does not furnish by rainfall we must apply. In our semi-arid district the amount of of water required for irrigation is uncertain, depending entirely upon the season.

It is evident that the actual cost of an irrigating plant will depend upon the size of the wheel, the depth of the well, and the man who is constructing the plant; some persons being capable of doing it much cheaper than others. The size of the mill, will, to a certain extent be determined by the depth of the well, and the area of land to be irrigated. The amount of land that can be covered with water will depend upon, the season, economy in the use of water, and the style of the pump.

The latter may or may not effect the cost, as a good one need not necessarily be more costly than a poor one, but upon the most effectual use of the power depends much of the success of this method of irrigation, other conditions being favorable. There are several styles of pumps in use made for different conditions. Where the water comes within a few feet of the surface rotary, and chain or bucket pumps are used with varying degrees of success. For deeper wells some force pumps are used, but probably the largest number are of the commonly known lift pump type. To get the best result from these it is desirable that the cylinder be as near the bottom of the well as practicable for it is more reliable to lift water than to raise it by suction. The inlet should be if possible as large as the cylinder. The outlet should be free. The flow of water should not be suddenly checked by short turns in the pipe, in shallow wells this one thing may cause a large per cent of the loss of power.

Thus we see that there are quite a number of factors to be taken into account in determining the cost of obtaining an adequate supply of water. The depth from which water can be profitably raised is a disputed question, and one that in all probability will not be settled for some time yet. One man may pump his water 25 feet and succeed, another try it at 30 and fail. So many of these factors come in to effect the result, that it is difficult to determine where success ends and failure begins. Good authorities claim, that, in Sherman County, pumping from a depth of 50 feet is an assured success. Some places they have to go only a few feet for water, others deeper. At Greeley Kansas, they are pumping from a depth of 200 feet, with 3 and 4 inch cylinders, enough water to irrigate from one to three acres. Near Goodland, Sherman Co., a man with a 16 foot mill, pumps, from a 120 foot well, sufficient water to irrigate a five acre orchard. M. B. Tomblin of the same place has a five inch tubular well over 200 feet deep, and expects, with a 16 foot mill and 500,000 gallon reservoir, to irrigate 20 acres. Experiments show at Goodland, that for $350 a plant can be built that will water from 10 to 20 acres. Mr. Diesman, who has contributed much valueable knowledge to irrigation, constructed the first plant for this purpose in Finney County. It cost him complete, with well, $300 and will furnish enough water to cover 10 acres. He says it could be put up cheaper now. In Cheyenne County, there is a six-inch well 190 feet deep from which enough water is pumped by an 8 foot aermotor to water 40 head of stock and a family garden. It cost complete $322.

Some of these, perhaps, are exceptional cases in which the effect was produced by purely local conditions, and so it would not be safe to draw any conclusions, except the very obvious one, that such a thing is possible. Undoubtedly, with improved machinery, the depth, from which water can be profitably pumped, will be increased. In many instances the facts given are not sufficient to give a clear idea of the conditions which really determine the efficiency of the plant. From the data available, at the present time, we would not be justified in drawing any definite conclusions, or make any rules that would hold good, either in regard to the cost of a pumping plant, unless all the circumstances are known, or from how great a depth can water be profitably pumped. To a depth of 50 feet there seems to be no question as to its success.

The location for the mill should be carefully selected. The surroundings should be studied, to make the ditches straight as possible, thus preventing excessive evaporation and loss from seepage. As a rule it should be placed upon the highest ground to give plenty of head for the easy flow of the water. Some regard should be taken for the convenience of the family, and instead of the dwelling determining the location of the mill, the reverse should be true. In this way the garden will be convenient, water plenty for domestic use and stock purposes, and when not needed for pumping the power may be put to some other use. The velocity of the wind varies with the distance from the earth. Compared with 50 feet the velocity at 100 feet from the ground is 1.2 greater, at 25 feet .9 as strong. In order to get the wheel above obstructions and to take advantage of this increased velocity, the tower should be as high as safty will permit. Additional safty may be gained by the use of guy ropes.

The value of the wind mill is wholly subservient to its motive power, and in spite of whatever good qualities it may have, the wind is capricious. Sometimes when we care not whether it blows or not then it blows the hardest, at other times when we wish to utilize the power, a calm prevails. Evidently if we wish to make an effective use of the power and make it reliable, some means must be provided by which the water, when not needed for immediate use, may be stored, in case the wind will prove fickle. To provide for such emergencies small earthen reservoirs can be constructed. One hundred feet square seems to be a popular size, and one adequate for all ordinary purposes. The inside should be plowed and scraped out with a common slip scraper, or any other cheap way. The banks should be from four to five feet high. twelve feet wide at the base and three at the top. Use only the soil from the inside, so the ground outside where the garden ought to be will not be spoiled. The banks may be sodded to prevent cutting, washing, and seepage, and besides it makes a much neater appearance. Pulverize thoroughly the soil in the bottom of the reservoir, and set the pump to going. While the reservoir is slowly filling up, drive several teams of horses or a small drove of cattle around in it, until a soft mud is made. This will settle into, and fill up the pores of the soil and make the reservoir practically water tight. Such a reservoir will require the labor of one team and two men from 6 to 10 days, and when completed will hold from 250,000 to 300,000 gallons. The reservoir never ought be let go dry or the puddling will have to be done again. If the reservoir be constructed as here described the water cannot all run out, because the bottom is lower than the ground outside. In the south west hundreds of just such reservoirs have been constructed within the last year. With such a body of water an excellent opportunity is afforded to have a stock of fish, thus the family larder may be kept supplied with an occasional mess of fresh fish. The outlet of the reservoir should be screened to prevent the escape of the small fish, and if the gate be accidentally left open, they will all be safe since the water cannot all run out.

It is well to be somewhat conservative about the possibilities of successful irrigation by this method - do not invest $300 or $400 or $1,000 in a plant and have to mortgage your farm to pay for it. Better begin with a smaller, cheaper plant, enlarging as your experience increases, making your progress slow and sure. All over our western plains there are hundreds of mills standing idle three fourths of the time when they might be running, if the power were only turned on. Here is a first class opportunity for the farmer to begin, and every one ought to improve it. If you have only a small plant make use of that; get to work and learn the proper use of water; experience counts for as much, in this, as in any other, enterprise. If every man would build only a small reservoir and let the water into it when not needed for other purposes, he would be surprised at the area of land that can be watered, and any man with such a plant; who does not furnish his table with fresh vegetables, has only himself to blame even in dry, windy Kansas. You may not feel like bothering with such a little garden patch, but if you can, from it, supply your necessary wants, is that not far better than having starvation staring you in the face? Scores of people have gone out on the western plains to get a home, and after years of hard labor have been compelled to abandon them for the lack of one thing, water. Good authorities say, that with proper irrigation a family may be provided with all the necessities of life, on from one to two acres. Had it been possible for those people to practice irrigation on a small scale, it might have been the means of saving their hard earned homes.

Irrigation with wind mills does not mean the watering of 160 acres planted in corn or sown in grain, undoubtedly such a practice would not be profitable. We must raise more valueable crops with a greater diversification of products. Our present methods of farming must be thrown aside for better ones. All this means intensive rather than extensive farming. It means a more self dependent people. It means the establishment of many small homes, each one supporting well a rural family, while they may never become rich they certainly will not starve; an irrigated farm never fails. There is room on our broad prairies for thousands of people without danger of crowding, and here may be a partial solution of the question of reducing the over populated condition of some of our cities. Many of these people would go into other occupations if they received a little assistance and knew where to go. Irrigation means a more habitable country with a denser population, favoring superior educational facilities, and the establishment of churches, to exert their moral influences. Irrigation in western Kansas means all possible things. Water we must have, without it we have nothing, with it everything. without it we must emmigrate, with it we can irrigate.

Fred E. Rader.